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OIL BURNERS FOR HOME HEATING[1]

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INTRODUCTION

Many types of automatic power-operated oil burners designed especially for home-heating purposes have been placed on the market within the last few years. The use of oil fuel appeals to many home owners because of the relief from furnace attendance and the freedom from dust due to handling coal and ashes. Automatic regulation of the heat is another attractive feature.

To meet the demand of prospective purchasers of this type of heating equipment for reliable information, the United States Department of Agriculture has tested a number of oil burners of different design and has prepared this circular, based on the results of the tests, in which an attempt has been made to give the information necessary for the home owner to make his own selection.

This circular deals only with power-operated types of oil burners. Distillate burners suitable for heating small buildings and which do not require power for operation are described in Circular 335.[2]

OIL FUELS

Oil fuels are now commercially known as domestic fuel oils, no. 1, no. 2, and no. 3; and industrial fuel oils, no. 4, no. 5, and no. 6. Sometimes the fuels are referred to as light, medium, and heavy domestic oils; and light, medium, and heavy industrial oils. For most of the domestic burners of the present day, the manufacturers recommend fuel oil no. 3, while some burn either no. 1 or no. 2 fuel only. The oils identified by successively higher numbers have correspondingly higher flash points,[3] contain more water and solid matter, and are less volatile and more viscous. The industrial fuel oils are generally too viscous for use in domestic burners. Such oils are generally heated before being fed to the burner, so that they will be more readily atomized. Preheating is not provided for in the usual domestic oil-burner installations.

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[1] This circular is a revision of and supersedes Department Circular 405, The Domestic Oil Burner.

[2] Senner, A. H. distillate burners. U. S. Dept. Agr. Circ. 335, 12 pp., illus. 1934.

The heating values of the different grades of oil fuels differ somewhat. A light oil is usually thought to have a greater heating value than a heavy oil, and this is true on a pound basis. However, fuels are customarily sold by the gallon, and the heavier oils contain a greater number of heat units per gallon than the lighter oils. They also are generally cheaper. Table 1 shows approximate average heat values of various oil fuels for domestic use.

TABLE 1.—*Heat content of certain oil fuels*

Oil	Heat units	
	Per pound	Per gallon
	B. t. u.[1]	*B. t. u.*[1]
Kerosene	20,000	136,000
No. 1 fuel oil	19,850	137,000
No. 2 fuel oil	19,700	140,000
No. 3 fuel oil	19,500	141,000

[1] A British thermal unit (B. t. u.) for practical purposes may be defined as the amount of heat necessary to raise 1 pound of water through 1° F.

As it is not practicable for the average home owner to make tests of oil or to have them made, his safest course is to purchase his fuel from a well-established and reliable source.

TYPES OF OIL BURNERS

There are on the market a variety of oil burners for use in house heaters. Their primary function is either to vaporize or to atomize the oil fuel and so mix it with air that proper combustion will result under suitable conditions of temperature. Burners generally may be classed then as either vaporizing or atomizing, but one important class of burners combines both vaporization and some degree of atomization. This is the so-called blue-flame rotary type.

VAPORIZING TYPE[4]

There are two principal types of true vaporizing domestic oil burners in use at the present time, but with so many modes of burning oil it is impractical to include herein reference to all the subtypes. The first of these two principal vaporizing types is that which mixes air and oil vapor before combustion by means of a pot or retort and a system of air distribution. A partial cross section of a burner of this type is shown in figure 1.

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[3] The flash point of an oil fuel is the temperature at which the liquid, on being slowly heated under definite, specified conditions, begins to give off vapor in such quantities that when a torch is applied it will ignite momentarily, causing a flash. A flash point of 100° to 200° F. is considered to be within safe limits for fuels used in domestic furnaces. Commercial standard specifications for domestic and industrial oils are obtainable from the Division of Trade Standards, National Bureau of Standards, Washington, D. C.

[4] The vaporizing type of oil burner referred to in the following publications was the old-fashioned spreader plate type:

SENNER, A. H. THE DOMESTIC OIL BURNER. U. S. Dept. Agr. Circ. 405, 30 pp., illus. 1927.

——— A STUDY OF THE OIL BURNER AS APPLIED TO DOMESTIC HEATING. U. S. Dept. Agr. Tech. Bull. 109, 84 pp. illus. 1929.

These two publications stated that the combustion and general type of service obtained from the spreader-plate vaporizing burners were far from satisfactory. However, the vaporizing burners now generally employed in domestic heating and to which the following discussion refers are entirely different from the spreader-plate burner. The service obtained from the newer vaporizing burners is of a very much higher order than that obtained from the vaporizing burners discussed in the earlier publications mentioned. The vaporizing oil burner discussed in this circular is not the same as the so-called "distillate" burner dealt with in Circular 335 (see footnote 2).

In this burner the oil and air are delivered to the combustion chamber by means of a mechanism consisting of a blower, motor, and oil-control valves, most of which are located under the hood (*h*). The air is delivered to the mixing chamber or "retort" through the delivery tube (*g*) and the oil is fed to the chamber through oil line (*f*). The gas-pilot tip (*e*) provides the ignition on the gas-ignition type burner illustrated although electric ignition is also offered by the manufacturers. The oil flowing to the bottom of the combustion chamber (*d*) is vaporized and premixed with air supplied positively by the blower, principally through the air distributor (*b*). By premixing is meant that the vaporized oil and the air required for combustion are principally mixed before ignition takes place. The flame (*a*) burns well out of the chamber and the chamber itself does not become very hot, because of the circulation of air around it (some air is also delivered through ports (*c*)) and because of the presence of the evaporating oil on the bottom of the chamber. Only the mixing chamber and a small portion of the tube (*g*) project into the boiler and the mechanism housed by hood (*h*) is external to the boiler.

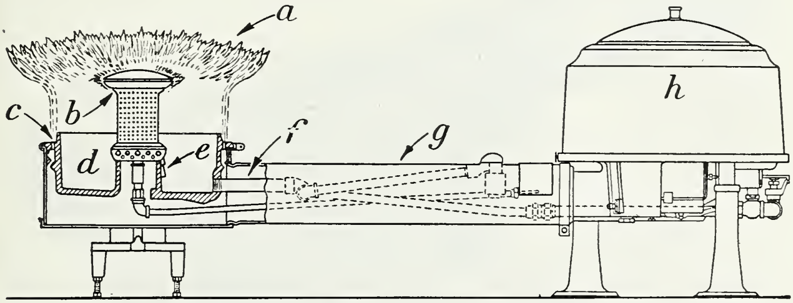

FIGURE 1.—Pot-type vaporizing burner: *a*, Flame; *b*, air distributor; *c*, ports; *d*, combustion chamber; *e*, gas-pilot tip; *f*, oil line; *g*, delivery tube; *h*, hood.

Another of the two principal types of vaporizing burners is one which utilizes a mineral wick in the bottom of the pot and an air-distribution system for mixing the oil vapor and air in the proportions required for combustion.

Because the vaporizing burners operate by boiling or vaporizing the fuel, they must be supplied with a relatively free-boiling fuel and one which leaves only a relatively small solid residue after burning. This means in practice today that vaporizing burners are limited to the use of fuel not heavier than the no. 2 of the commercial grades (p. 1).

There is one interesting application of the vaporizing burner to automatic heating in which the flame ordinarily is not entirely extinguished when the room temperature has been satisfied; instead there is a so-called "high-low" control of the flame resulting in more nearly continuous operation. The proponents of this type of burner maintain that greater comfort is realized in this manner because of the more nearly continuous input of heat to the heating system. They claim also some economy because of what might be termed the "throttling" effect of this type of control. This mode of operation seems theoretically correct, but only a small fraction of the domestic oil burners function in this fashion.

ATOMIZING TYPE

In one mechanical-type atomizing burner, the oil is put under pressure and forced through a small nozzle opening to break it up into minute particles so that it enters the furnace as an exceedingly fine spray. Together with this, air is supplied by a blower or pump and so regulated as to bring about the proper mixture of the air and fuel. This type of burner is most familiar to the general public as the so-called "gun" type. (The term "pressure-atomizing" burner would be more exact and it is probable that in the future this term will be used more commonly.) Use of the blower does not necessarily cause excessive amounts of heated gases to be blown through the boiler and up the stack.

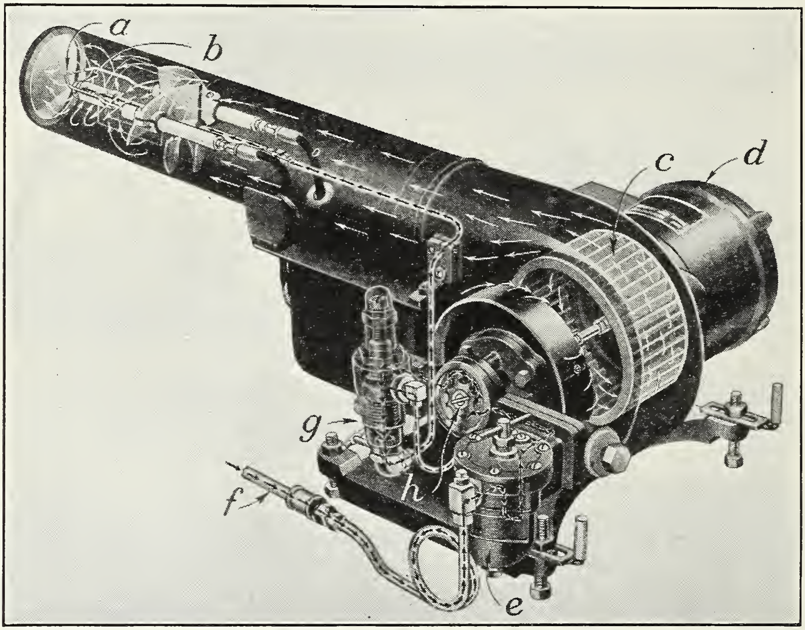

FIGURE 2.—Gun-type atomizing burner: *a*, Ignition points; *b*, nozzle; *c*, fan; *d*, motor; *e*, filter; *f*, oil line; *g*, pressure-regulating valve; *h*, oil pump.

Referring to figure 2 the operation of the gun-type burner is as follows: Oil is fed to the burner from the oil-storage tank through the line (*f*) passing through the filter (*e*) and thence to the oil pump (*h*). The pump forces the oil through the pressure-regulating valve (*g*) and from here the oil is delivered at a constant pressure, generally about 100 pounds per square inch, to the nozzle (*b*) from which point it is sprayed into the furnace in a fine mist at the same time being mixed with air which is supplied by the fan (*c*). The motor (only a small fraction of a horsepower) (*d*) supplies the required power.

The atomization of the oil may be effected by the use of the energy contained in air when compressed to certain pressures and this gives us the general type known as the "air-atomizing" burner. The air pressure utilized may be either low, medium, or high, depending on the particular design. The pressure-atomizing and air-atomizing burners may assume the ordinary gun-type form and spray the oil and air into the furnace horizontally, or the spray may be directed downward at an angle, vertically upward into the combustion space, or in some other manner, depending on the general effect desired by the designer.

There is another general type of atomizing burner known as the "vertical-rotary" type. In this type of burner, the mechanism is placed entirely or almost entirely inside the base of the boiler and the oil is atomized by being thrown from the rim of a revolving disk or cup. The disk or cup speed in some types is relatively high, and the motion is obtained—either by direct or indirect drive—from an electric motor. Figure 3 illustrates a motor-driven centrifugal atomizing burner of the vertical-rotary type. In some variations of the vertical-rotary type, the atomization is effected at least partially by the use of air.

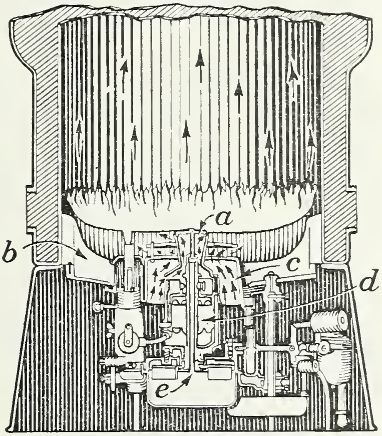

FIGURE 3.—Vertical-rotary centrifugal atomizing burner: *a*, Atomizing burner; *b*, refractory chamber; *c*, air space; *d*, motor; *e*, hollow shaft.

The vertical-rotary atomizing burner is placed entirely within the boiler. In the burner shown in figure 3 the oil passes up through the hollow shaft (*e*) of the motor (*d*) and is sprayed at high speed from the atomizing cup (*a*) mounted on the top of the shaft. Oil is fed to the base of the hollow shaft by gravity. The air represented by the arrows is brought through the space (*c*) and passes up to mix with the atomized oil. This mixture is thrown outward and the flame burns with a characteristic yellow appearance. The refractory bowl-shaped chamber (*b*) serves to improve the combustion by catalysis.

Another major subdivision of the atomizing type of burner is the horizontal rotating cup type (fig. 4). In this case the oil is atomized by being thrown from the inside of a spinning horizontal cup. At the same time a blast of air is directed into the furnace along with the atomized oil.

Atomizing burners in general, and this holds for the several principal types mentioned, frequently use the heavier oils, such as no. 3.

BLUE-FLAME ROTARY BURNER

One of the most important subdivisions of domestic oil burners and one which deserves to be classified as unique is the vertical-rotary blue-flame burner. This burner, because of its so-called floating flame, has often been designated as a wall-wiping type. This burner functions principally by vaporization, but also to some extent by atomization. By reference to figure 5 it can be seen that this burner is of the vertical-rotary type placed entirely within the furnace. The oil is sprayed from the revolving tubes (*b*) and thrown against the target wall (*d*) made of metal or clay, which is placed around the combustion chamber wall, together with the necessary air which is supplied by means of the fan. The oil is delivered across the hearth (*a*) in fairly large particles so that the small amount of atomization realized is gotten by impingement on the refractory material around the hearth. After ignition has been established (the igniter located at (*c*)), the hearth and the target wall (*d*) or flame ring as it is sometimes called, become somewhat warmed resulting in vaporization of the oil and its premixing with air prior to burning. The resultant combustion in this type of burner produces the so-called blue flame. In practice, however, the most satisfactory type of flame for this class of burner is that which has a blue base with yellow or orange tips, rather than completely blue. There is, however, no objection to the all-blue flame if it can be maintained and if good ignition can be attained with the burner so set.

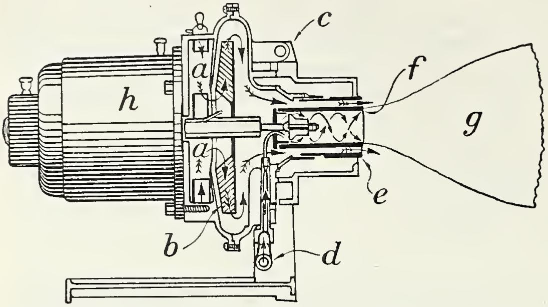

FIGURE 4.—Horizontal rotating cup type atomizing burner: *a*, Air path; *b*, fan; *c*, burner hinge hanger; *d*, oil inlet to burner; *e*, adjustable angular vane air nozzle; *f*, rotary atomizing cup; *g*, flame; *h*, electric motor.

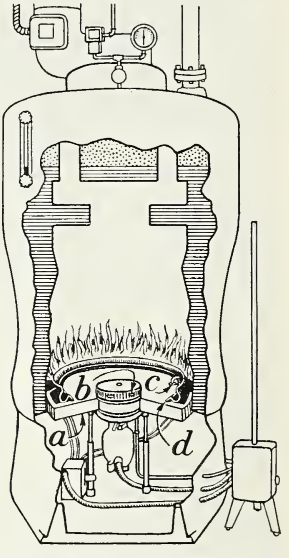

FIGURE 5.—Blue-flame rotary burner: *a*, Hearth; *b*, revolving tubes; *c*, igniter; *d*, refractory material.

This flame is very much different in appearance from that produced by the vertical-rotary atomizing burner illustrated in figure 3. It is different not only because of its blue color, but also because it burns almost directly against the vertical boiler walls and does not begin to burn until the mixture reaches the target ring, whereas the flame in the case of the burner shown in figure 3 begins just after the mixture leaves the atomizer cup.

Although the vertical-rotary burner is placed entirely within the furnace, it is not subjected to such a degree of heat as will cause undue depreciation of parts of the burner. All of the air supplied for combustion is introduced in such a way that it passes directly over the burner parts that are adjacent to the flame and to the heated portion of the burner such as the hearth. In this manner the burner is maintained at a temperature low enough to safeguard it against damage from overheating. Experience has shown that no unusual depreciation of the vertical-rotary or similar types of burners results from placing them within the base of the boiler.

IGNITION

Burners may be classified further according to the manner in which the fuel is ignited. With any type of burner it is necessary to introduce a flame or electric arc within a region which is filled with a mixture of oil and air in such proportions as to make it comparatively easy to ignite. The principal ignition methods used today may be roughly classified as gas, electric, gas-electric, and oil pilot. With a gas pilot ordinary illuminating gas is used to provide a continuous source of heat, and is so placed as most effectively to bring the mixture of oil and air to such a temperature as to cause combustion. The pilot light is sometimes caused to expand at the time that the burner "comes on," and by this means the danger of extinguishing the pilot light is somewhat lessened and ignition is presumably hastened.

In the case of electric ignition, a spark is introduced into the region of the charge. The spark may be either continuous or intermittent. In the former, the spark continues during the entire time the burner is in operation. In the intermittent type, the spark is active only during the time necessary to ignite the charge. Various advantages are claimed for each type by the designers. The electric ignition is fast becoming the most common mode. In the gas-electric type a gas pilot is turned on, the gas being ignited by a spark. The pilot light then ignites the charge. Still another device is the oil-pilot light in which a continuous oil-burning flame is maintained for the purpose of ignition. Many favorable characteristics are advanced by advocates of these various devices, but the type of burner selected depends on whether gas or electricity or both are available.

FACTORS IN THE SELECTION OF AN OIL BURNER

Satisfactory results from the burning of oil fuel are dependent on several factors. In the first place, whether oil or some other fuel is used, the entire heating plant must be designed and laid out according to accepted principles of heating. This means that for satisfactory service the circulating system for the hot water, steam, or warm air must be properly proportioned and installed, and that the boiler or furnace must be of suitable size for the load imposed on it.[5] If a boiler or furnace of inadequate capacity is used, the result will be overloading and a loss in over-all efficiency.[6] This is particularly true in the case of oil burning, in which the losses of heat up the chimney may be very large if both parts of the heating system are not adapted to each other.

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[5] For information regarding proper size of the heating plant see the following publications: SENNER, A. H. HEATING THE FARM HOME. U. S. Dept. Agr. Farmers Bull. 1698, 18 pp., illus. 1933.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. GUIDE . . . v. 1–14, New York. 1922–36. Manufacturers' catalogs.

[6] "Over-all efficiency" is a term applied to a complete heating installation, including the heater itself, which indicates the percentage of the heating value of the oil that is utilized for warming the house. The over-all efficiency is the ratio between the heat energy of the fuel which is used in heating the water or air (not air passing up the chimney), as the case may be, to the total amount of heat contained in the fuel. For example, suppose that for each gallon of an oil containing 140,000 heat units, 70,000 heat units are actually made available for heating the house; then the over-all efficiency is 70,000 divided by 140,000, or 50 percent. No other "efficiency" is significant. It is true that a high so-called burner efficiency is imperative, but this does not insure high over-all efficiency.

CAPACITY

It is, of course, essential that the oil burner selected be of sufficient capacity to provide for the maximum heating demand. The practice of manufacturers in supplying heating capacities varies considerably. Some make a series of burners that are of similar construction but of different sizes and oil-burning capacities; others make two or three types of burners, each of which can be so adjusted as to fit a range of heating demands; still others make but one burner and depend upon adjustments to accommodate the various heating requirements. At least one-fifth of a gallon of oil per hour will be required for each 100 square feet of hot-water radiation, and about one-third gallon of oil per hour for each 100 square feet of steam radiation, during the severest winter weather. This does not provide for domestic water heating. The manufacturer of the water-heating equipment or an authorized agent should be consulted to determine this requirement. These figures are approximate peak demands, to be used only for determining the size of burner mechanism which should be supplied. It is not to be expected that the burner will operate at this rate during the entire season, therefore these figures cannot be used for computing the seasonal fuel consumption.

SELECTING A BURNER SUITED TO THE BOILER

One of the most common questions asked by a prospective purchaser is "Which is the best type of oil burner, the gun burner or the vertical-rotary or the pot type or some other type?" There is no single direct answer to this question. Each type of burner probably has a different efficiency in any given boiler. Therefore the burner efficiency can be properly considered only in connection with the boiler in which it is to be used.

Some types of boilers and burners naturally operate together better than do other combinations. For example, vertical-rotary burners do best in round boilers, or those in which the length is not more than 75 or 100 percent greater than the width. They generally do not operate well in rectangular boilers of rather elongated firebox dimensions.

The pot- or gun-type burner can almost always be used in either round, square, or elongated types of fire pots. On the other hand, the vertical-rotary or pot-type burners are more efficient than the gun burner in the many boilers which are deficient in flue travel[7] and in boilers which are overloaded. Many manufacturers realize that the gun-type burner requires additional flue travel in the heater, or the equivalent in some sort of economizing device, and are recommending either the addition of sections to an existing boiler which may have inadequate heating surface or the installation of an economizing unit such as will be described subsequently. Such steps may bring up the efficiency of the installation to a sufficiently high value. With special oil-burning boilers, complete boiler-burner units, or coal-burning boilers with large amounts of heat-absorbing surface, substantially equal efficiencies can easily be attained for each of the several types of burners.

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[7] The burning gases of the oil flame of a gun burner do not transmit heat to the firebox as effectively as does a burning mass of solid fuel; therefore a heater of minimum size for satisfactory service when burning coal is likely to be deficient in heat-absorbing surface when used with a gun-type oil burner.

EFFECT OF GRADE OF OIL ON ECONOMY OF OPERATION

Another question asked frequently by the prospective purchaser of an oil burner is, "Which is the cheaper fuel for heating the house, the lighter fuel such as no. 1 or the heavier fuel as no. 3?" Generally, the householder will find most economical the cheapest fuel that the Underwriters' Laboratories (p. 24) list for the burner in question. As it affects the choice of a burner, however, the question is difficult to answer directly because in a particular boiler the types of burners which consume the different grades of fuel may vary widely in the efficiency of burning the fuel and in the quantity of heat made available for heating the house.

The heaviest grade of fuel that can be used is fixed by the design of the burner with respect to method of atomization or vaporization, type of ignition, etc. The vaporizing burners invariably are designed to burn only the no. 1 or no. 2 fuels. The atomizing domestic burners at the present time use oil as heavy as no. 3. If the efficiencies of all types of burners when used in all types of heating plants were the same the most economical burner, from the standpoint of cost of fuel, would be the one that utilized the heavier oil provided that, as is generally the case, the heavier oil costs less per gallon. However, it is often found that in a particular boiler, the difference between the efficiencies of a burner that can use only the lighter and generally higher priced fuels and of one that can use the heavier fuels may be enough to make the lighter oils equally or even more economical.

The difficulty of making satisfactory general statements concerning the effect of price and grade of oil on heating costs is shown by certain investigations conducted by the Department of Agriculture. The seasonal cost of oil with a rotary wall-wiping blue-flame burner using no. 2 oil at 7½ cents per gallon was about 9 or 10 percent greater than the cost of heating with a pressure-atomizing burner using no. 3 oil at 6½ cents per gallon, when these burners were used in a rectangular sectional boiler with very liberal heat-absorbing surfaces. However, when used in a round boiler with rather limited heating surface the costs of oil were approximately equal, even though the no. 2 oil costs more per gallon than the no. 3 oil and contains slightly less heat units per gallon. If the no. 2 oil had been supplied to both burners, as is very commonly done, the cost of oil would have been higher for the pressure-atomizing burner than for the rotary burner in either boiler. The cost of oil for the pressure-atomizing burner in the round boiler would have been about 18 percent more than for the rotary burner and in the rectangular sectional boiler would have been 5 or 6 percent more. These figures do not necessarily apply to all round boilers nor to all rectangular sectional boilers.

In many localities the heavier fuels are not available, or, if available, they are priced no lower than the lighter fuels. Under such conditions, since the difference in the heat values of the several fuels is almost negligible, the fact that one burner can burn no. 3 oil while another must burn no. 2 is of no practical significance.

ULTIMATE TYPE OF BURNER

It is frequently asked, which of the several types of burners will be the ultimate types, which are becoming obsolete, and which are gaining in relative usage and importance? With the present supply of relatively light fuels, which will probably exist for some years to come, we should find examples of all of the present important types of burners on the market for an indefinite period.

However, more and more manufacturers are going to the gun burner because of its simplicity, ease of design and manufacture, and relative freedom from patent complications. Not only is the gun burner simple to build, but it is also easy to install and service. This may be said also of those pot-type burners that do not require a specially built combustion chamber as do most other types.

REMOVABILITY

Some buyers insist upon a burner that can readily be removed to allow replacement of the grates in order to return to coal burning if the oil burner should fail or if electric current becomes unavailable for some time. Especially in isolated places, there may be loss of electric power for days at a time during severe storms; or the roads may be impassable so that the service man is not available for a considerable time. Under such circumstances an owner should insist upon a burner that can be pulled out by inexperienced labor in order that he may return temporarily to the use of coal.

AMOUNT OF NOISE

A burner that is noisy is highly objectionable. The purchaser may insist on a noise clause in his contract so that, if the noise proves unbearable after a reasonable trial, the contractor shall remove the burner and relieve the purchaser of all obligations. All burners create some noise, but with most of the modern types, it does not prove enough to be objectionable under average house conditions. There are some exceptions to this rule however, hence the noise clause.

AVAILABILITY OF ELECTRICITY AND GAS

Most domestic oil burners of today require electricity or both gas and electricity. If both these facilities are not available, the choice of burners is restricted.

PRICE

Prices of domestic oil burners have decreased in the last several years, and there is considerable variation in prices of equipment of apparently the same general design and quality. Some gun burners can be installed for approximately $250 with 275-gallon tank and all controls (except perhaps a low-water cut-out). Other gun burners, entirely similar as far as the layman or the informed oil-burner agent can detect, sell for as much as $325. The rotary and some of the pot or retort types of burners average higher in price than the gun burners. The Department of Agriculture has not yet been able to find any definite relation between market price and quality.

SERVICE REQUIREMENTS

It is generally agreed that the vertical-rotary wall-wiping blue-flame burner of most designs requires more servicing than do other types of burners. This does not mean that they are a constant source of trouble, but that for one reason or another they have required more service calls than other types for example, the gun type. This difference in service requirements however may actually mean very little to the user inasmuch as the service charges are frequently included in the price of the fuel oil.

RELIABILITY OF LOCAL REPRESENTATIVE

In selecting a burner it is well to keep in mind experiences of other purchasers, and to seek not the best burner but rather one that is handled by a reliable organization which employs capable men to service their product. It is generally safe to conclude that such an organization will handle at least a reasonably good burner.

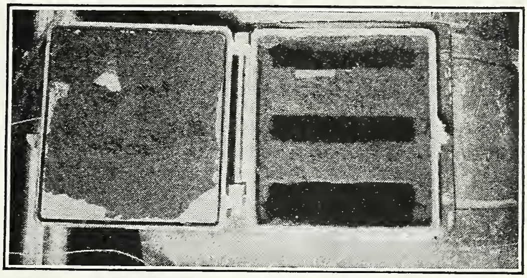
Figure 6.—Soot deposit in heating passages of boiler.

A first-grade burner improperly installed, or without opportunity of procuring service, will be unsatisfactory. All burners require some servicing. A burner that is installed by inexperienced workmen, even with the aid of explicit printed instructions, is very likely to prove unsatisfactory in operation.

ADAPTATION OF PRESENT HEATING PLANT FOR USE WITH OIL

Oil must be burned in a region of high temperature to obtain satisfactory combustion. Looking into an operating furnace, one probably would conclude immediately that this condition is always fulfilled, but it is not. When the mixture of oil and air is ignited, the temperature rises rapidly and the products of combustion quickly expand and fill the whole combustion space. The inner surface of the firebox of the boiler or furnace, by virtue of the high rate of heat transmission through iron and steel, has a considerable cooling effect on the burning gases that come in contact with it, and this cooling may arrest combustion prematurely and cause sooty deposits. Soot formation is to be avoided, as a deposit in the furnace or stacks leads to inefficiency and is a dangerous fire risk. Figure 6 shows a deposit of soot in heating passages of a water boiler. The proper use of fire brick and refractory cements, which are relatively poor conductors of heat and therefore become very hot, tend to prevent the contact of the hot and incompletely burned gases with the relatively cold walls of the furnace and thus to avoid soot formation and loss of heat in the form of unburned gases.

The form of the firebox is also important. Some shapes and designs are more suitable for certain types of oil burners than for others (p. 8). Some heaters can be made more suitable for burning oil by proper alteration in firebox shape through the use of refractory brick or cement. Proper installation of refractory material is one of the problems that must be solved by the oil-burner manufacturer or dealer before he can give reasonable assurance of satisfactory operation to the prospective buyer.

WARM-AIR FURNACES

Warm-air furnaces represent a large percentage of the heating plants of this country, and the adaptability of oil burners to this type of heater is of interest to many people.

Perhaps the principal difficulty to be overcome with old furnaces is the leakage of the products of combustion—gas and soot—through the joints of a cast-iron fire pot into the warm-air space of the furnace and thence into the rooms of the house. This condition may be more acute in the case of an oil burner than that of the ordinary coal-fired furnace because of the intermittent nature of the oil flame. As a rule, the burner either is operating at its maximum capacity or is entirely inoperative, as controlled by the room thermostat. The alternate heating and cooling has a tendency to loosen the seams and permit the passage of gases from the fire pot into the warm-air passages. To avoid this difficulty some oil-burner dealers insist that before the burner is installed the outer casing of the furnace be removed and the inner fire-pot sections be thoroughly inspected for the purpose of locating leaks, which then are closed in suitable manner before the outer shell is replaced. High-grade steel furnaces with welded joints satisfactorily resist the effects of the high temperatures of the oil-burner flame.

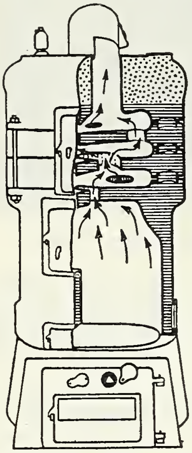

FIGURE 7.—Sectional view of round heating boiler, illustrating addition of sections to increase the heating capacity.

Modern air-conditioning units are frequently of the warm-air type, but such usually are so designed as to prevent leakage of products of combustion into the room. In the special oil-burning types of warm-air units the efficiencies are as high as those of the hot-water, steam, or vapor heating systems.

HOT-WATER AND STEAM BOILERS

In a large percentage of installations of oil burners in hot-water or steam heating plants the boiler is not properly designed for the efficient use of oil, either because of insufficient combustion space or because of inadequate gas travel or heat-absorbing surface. In general it is not practicable to increase the combustion space by any change in the existing boiler, but in many instances its heating surface can be increased so as to effect a considerable saving in fuel. Most heating boilers are built up; that is, they are composed of a number of castings bolted one on top of another as shown in figure 7, or one behind the other, depending upon the form of boiler.

Tests were conducted by the Department of Agriculture on a 25-inch round hot-water boiler with a gun-type burner to determine the savings to be realized by adding sections to increase the heating surface. The smallest boiler had four sections—base, fire pot, one intermediate, and dome. The next larger boiler had two intermediate sections, and the largest was a six-section boiler having three intermediate sections. These tests showed that to achieve the same heating results, the five-section boiler required 15 percent and the six-section boiler 25 percent less fuel than the four-section boiler. Thus it is often economical to add a section or two to a small boiler before installing an oil burner. Of course lack of head room sometimes precludes such alteration.

Some simple and inexpensive schemes can be used with otherwise inefficient boilers to effect material reductions in fuel consumption. One such expedient consisting of a baffle is shown in figure 8. In this four-section round boiler there is a very little flue travel and therefore very small opportunity for absorption of heat by the water. This type of boiler with an oil burner wastes heat up the chimney. The simplest scheme for reducing such waste is to put in a baffle, and the form illustrated consists of a sheet of metal supported on split fire brick or similar material in such a manner as to cause the hot gases to take the path indicated rather than to short-circuit directly from one opening to another. The baffle causes the gases to "scrub" the heat-absorbing surface more effectively.

The view shows the clearance that must be allowed between the circumference of the baffle and the boiler wall to permit passage of the gases. This opening must not be too small or a back pressure will be built up in the combustion chamber.

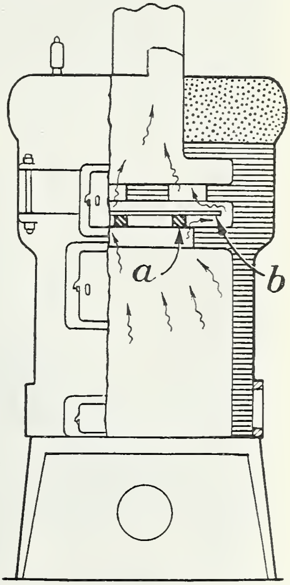

Figure 8.—Four-section round boiler showing use of baffles: *a*, Split brick: *b*, baffle.

Such baffling should be done by the burner agent with the aid of a draft gage to determine the draft in the combustion chamber, to avoid excessive stoppage of the flow of the products of combustion. Most oil-burner men are familiar with this or other forms of baffles, but many are not entirely aware of the appreciable reductions in stack temperature and increases in economy that are possible thereby. Tests by the Department of Agriculture show that the use of such a simple baffle in a four-section, 20-inch round boiler resulted in a decrease of approximately 125° F. in stack temperature with an accompanying saving of fuel of approximately 8 percent in doing the same heating job. Different types of burners lend themselves to different degrees of baffling. The gun-type, retort- or pot-type, and the yellow-flame vertical-rotary burner can withstand the effects of considerable baffling, but with the blue-flame rotary burner excessive back pressure often results in ignition difficulties.

Several oil-burner manufacturers have for some time been making equipment to be used in connection with existing boilers in order to improve their efficiency by providing additional heating surfaces. One such product, shown in figure 9, consists of two principal parts: (1) A water-containing casting lined with refractory material forms a combustion chamber and provides additional heat-absorbing surface which is tied in with the boiler by means of piping as shown. This gives what may be termed additional direct-heat surface. (2) Fingers of metal cemented to the surfaces of the upper flues, as shown, provide additional indirect heat surface to collect heat and transmit it to the boiler walls and thence to the water. These two components of the economizing system are not connected in any way, therefore either may be employed without the other if it is unnecessary or impractical to use both. Tests conducted by the Department of Agriculture on systems such as this indicate the possibility of saving as much as 25 percent of the fuel when using them with a small round boiler with the minimum number of sections.

Other types of economizers include water-circulating castings placed in the firebox, generally above the fire and above the combustion chamber itself, and tied in with the boiler in a way similar to that shown in figure 9. The department's tests show that the different forms of economizers are of greatest relative value when used in connection with gun-type burners in the smaller boilers.

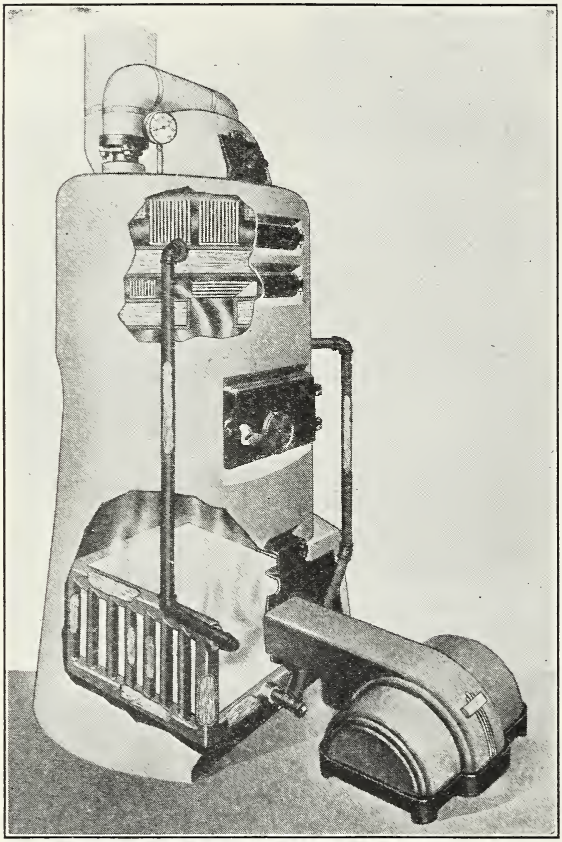

FIGURE 9.—Economizer equipment added to round boiler.

SELECTION OF NEW EQUIPMENT

STEEL AND CAST-IRON BOILERS

For many years there has been considerable discussion as to the relative merits of steel and of cast iron for domestic heating boilers. Use of steel boilers has increased rather markedly with the advent of the special oil-burning type of boiler which has become more popular in recent years. However, cast iron is still much used for special oil-burning boilers. This Department has not been able thus far to find any definite evidence as to the relative length of service that can be expected from the two types. There should be no inherent difference in efficiency between steel and cast-iron boilers, but because some of the cast-iron boilers are made in sections there is opportunity for skimping the number of sections, which sometimes has been done, resulting in low efficiency.

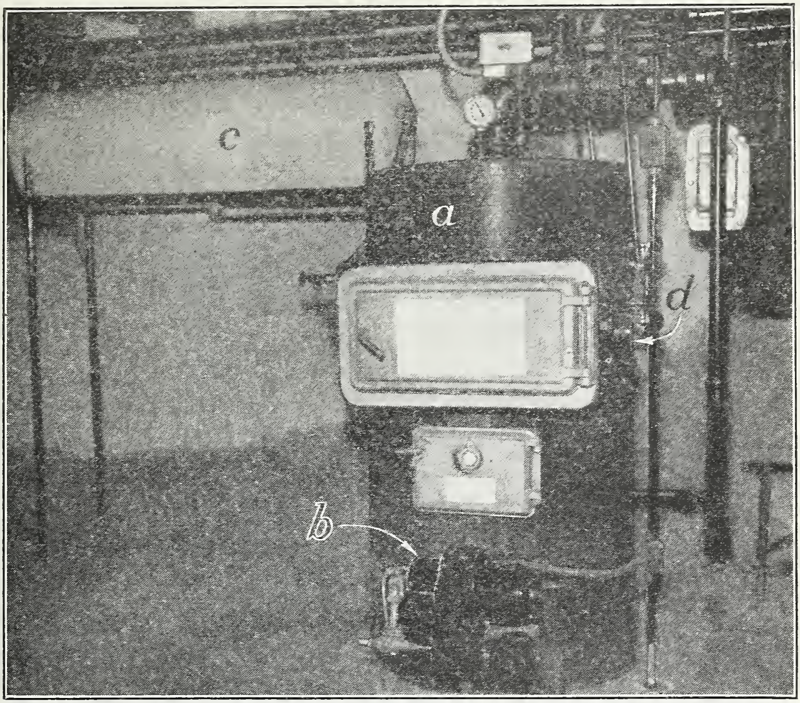

FIGURE 10.—Special oil-burning boiler of steel construction: *a*, Boiler; *b*, gun-type burner; *c*, domestic hot-water storage tank; *d*, automatic control device for maintaining temperature of water for year-around hot-water supply.

However, with intelligent design and proper selection of size of unit, including the right number of sections in the cast-iron type, equal efficiencies can be obtained with both types of boilers.

SPECIAL BOILERS FOR OIL BURNING

Many new boilers designed primarily for oil or gas firing, made both of steel and of cast iron, have appeared on the market during the past several years. Most of these have been well engineered and show good operating characteristics, and good appearance through use of attractive jackets. They frequently have coils for domestic water-heating built into them, and some even store the domestic water supply within the boiler thereby making it unnecessary to have a separate storage tank. Some provide means for garbage and trash disposal. Figure 10 shows one of the more recent special oil-burning boilers of steel construction. Figure 11 shows a special oil-burning boiler of cast iron. These units cannot be used for burning coal because they lack provision for grates. If one is certain that he will not wish to return to the burning of solid fuel, it is well to consider the use of a special oil-burning boiler when making a new installation, otherwise it will be safest to select a coal-burning type with sufficient flue travel for satisfactory burning of oil. When the type of burner to be used is known, it is well to consult the boiler manufacturer as to the type best suited for operation with the particular burner selected as well as to the size of boiler.

BOILER-BURNER UNITS

It is only a short step from the special boiler for oil burning to the so-called boiler-burner unit. The boiler-burner unit consists of a special oil-burning boiler, of either steel or cast iron, fitted with an oil burner. The units are designed to provide maximum efficiency for the particular burners that are used with them. A coil for domestic water heating is generally built into the unit. Such of these units as the Department of Agriculture has had the opportunity to test have been very efficient. Generally, the efficiency of the boiler-burner unit should be sufficiently higher than that of the average coal-burning boiler when used for oil burning to obtain a fuel saving of from 15 to 20 percent. At the same time, the boiler-burner units are almost invariably designed to provide year-round domestic hot water, and this mode of generating hot water sometimes results in additional savings. A modern boiler-burner unit is illustrated in figure 12.

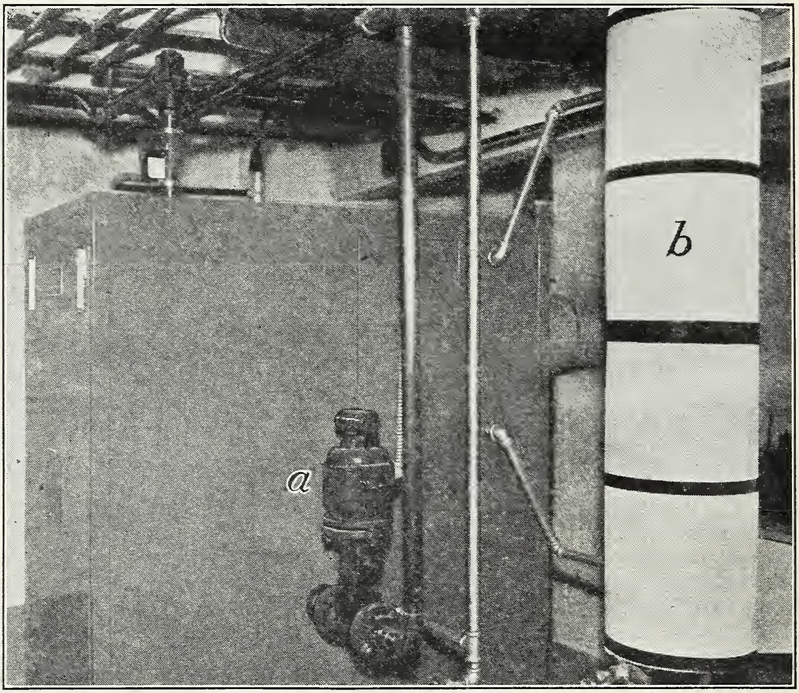

FIGURE 11.—Special oil-burning boiler of cast iron with enameled sheet-metal jacket. The burner is concealed by the cabinet: *a*, Circulating pump of hot-water heating system; *b*, hot-water storage tank.

The first cost of the boiler-burner unit may seem relatively high, but actually may not be so for all the items involved. In the case of a new installation comprising a boiler, burner, and hot-water generating equipment, probably the complete boiler-burner unit will cost no more; and any small difference in first cost will generally be offset by the higher average efficiency of the boiler-burner unit. If, however, an efficient type of coal-burning boiler is already installed, together with satisfactory equipment for the generation of domestic hot water, it will be more difficult to justify the replacement of such equipment by a complete boiler-burner unit. In such instances it probably would be economical to add a well-designed oil burner to the existing plant provided the boiler is in good condition and of a type suited to the use of oil fuel. Many householders prefer the special oil-burning boilers and boiler-burner units because they are of better appearance than some of the coal-burning boilers equipped with oil burners.

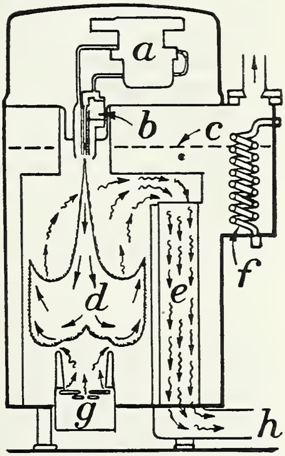

Figure 12.—Boiler-burner unit: *a*, Motor; *b*, burner head; *c*, water line; *d*, flame; *e*, tubes; *f*, coil for heating domestic hot water; *g*, secondary air duct; *h*, chimney connection.

YEAR-ROUND HOOK-UP FOR DOMESTIC HOT WATER

Means have been devised to broaden the scope of usefulness of the domestic oil burner by having it provide domestic hot water throughout the entire year.

With the advent of oil heat and the transition from the continuous coal fire to what is generally an intermittent oil fire, many complaints were made relative to the lack of sufficient hot water. To overcome this condition, several types of indirect water heaters were developed. They consist generally of a cast-iron jacket, connected by suitable pipes to the boiler in such manner as to form a circulating loop. Inside the jacket of the indirect heater is a coil, generally of copper tubing. This coil is connected to the domestic hot-water storage tank. In more recent designs the coils are built directly within the boiler, but are removable, and in some types no auxiliary storage tank is necessary. With such a hook-up it is impossible to overheat the domestic water supply to any serious degree. It should be borne in mind that connecting the domestic hot-water pipes with the heating boiler increases its load as well as that on the burner.

The year-round hot-water hook-up can be applied to either steam, vapor, or hot-water heating plants. It cannot be applied, however, to the warm-air plants thus far marketed. With this type of hook-up the burner operates the year round, and when the heating load is removed during the warm months the instruments controlling the temperature of the stored water assume the master control of the oil burner. It is not necessary for the householder to make any change whatever in the thermostat or other control settings when transition is made from the heating season to the summer season when domestic hot water is the sole function of the oil burner. The system is truly automatic.

The cost of installing the year-round hot-water hook-up in a steam plant is relatively low, ranging possibly from $50 to $100 according to size and other conditions, whereas for the hot-water type of heating system the installation will cost $200 or more because more equipment is required.

Three principal advantages claimed for the year-round hot-water hook-up are (1) a saving in cost of hot water generated; (2) greater convenience in operation as compared, say, with a coal-fired water heater, or with a manually operated kerosene-burning heater during the summer months; and (3), the fact that when a year-round hook-up is used the burner operates in the summertime and presumably depreciation is minimized.

Effecting a saving in heating domestic hot water the year round with oil depends upon several factors, principally the relative cost of the different fuels that might be used and the quantity of hot water demanded. When compared with heating hot water with small-size coal heaters, it is doubtful whether any great saving can be made. As compared with using manufactured gas or electricity, at an average of rates throughout the country, the year-round heating of water by means of oil fuel should generally result in some saving, especially if a large quantity of hot water is heated. The Department of Agriculture has not had opportunity to make definite comparisons between the costs of heating domestic hot water with the year-round hot-water hook-up and with other modes.

AUTOMATIC DEVICES

If an oil flame is not controlled in some manner, it may build up excessive temperatures and pressures in the heating system. If the drafts of a coal furnace are inadvertently left open, temporary overheating or increase in pressure may occur, but in all probability no serious results will be produced. With the oil burner, however, overheating will continue as long as the fuel supply lasts. Considerable attention has therefore been given to the design and application of satisfactory devices to control the functioning of the automatic domestic oil burner.

THE ROOM THERMOSTAT

The thermostat is the device that renders the automatic burner active or inactive in the process of maintaining desired room temperatures. In the thermostat there is a member actuated by temperature changes, which operates to shut off and start the burner. The thermostat is placed in a room, generally the living room, in which it is desired to maintain a constant temperature and is adjusted by setting a small pointer at the desired temperature on a graduated scale. The thermostat should be properly located to control the room temperature. It should be placed on an inside wall and protected from abnormal drafts of air, as from stairways and entrances. It should not be placed too near chimneys, radiators, warm-air registers, hot-water or steam pipes, or other direct sources of heat. Particular care must be taken to avoid placing of the thermostat near concealed steam or hot-water pipes. Many instances of unsatisfactory burner operation have been traced to improper placing of the thermostat.

Until very recently thermostats were designed and built to operate on a 2° differential, generally over a range of 30° F. or from 50° to 80°. For example, if a room temperature of 70° is desired, the thermostat would be adjusted so that when the surrounding air had brought the temperature of the instrument up to 70° the electrical contact points would open the burner circuit and shut off the burner and the flow of oil. Then when the thermostat temperature dropped 2° the contact would close the burner circuit and reestablish the fuel flow and heating flame.

Many present-day thermostats, however, operate on a very much smaller temperature differential than this, with the result that the comfort is improved. The so-called "clock" thermostat was devised to obviate the setting of the thermostat by hand when periodical changes are desired. The clock thermostat permits the room temperature to be reduced at night, during the sleeping hours, and raised in the morning in order that the occupants may arise in a house of comfortable temperature. This reduction in night temperature permits also some fuel saving. The clock thermostat was made in several styles, the first of which was the so-called 8-day clock. However, with the advent of the electric clock, that type of timepiece was adopted and the necessity for winding was thereby eliminated. More than one temperature set-back per day can be had with the modern clock thermostats so that, in the case of families who are away from home during the day, the house temperature can be reduced automatically during this time as well as during the night period, and be advanced automatically so that the family can have the desired room temperatures upon returning in the evening as well as upon arising. Such burner operation naturally results in appreciable fuel saving with no accompanying loss of comfort.

Another feature of design incorporated into up-to-date thermostats reduces the discomfort that may result from intermittent heating such as is experienced with the older type of domestic oil-burner controls. The so-called "cold 70" is a condition of discomfort which sometimes exists when the burner has been inoperative long enough for the radiators to have become cold, even though the room temperature at the thermostat may be as high as desired. The explanation of this is in the fact that the air becomes stratified. Also, there may be some reversal of the flow so that the cold air from windows drops down and flows along the floor unheated by the radiators. This condition has been recognized by temperature-control manufacturers, with the result that the so-called anticipating or heat-accelerated types of thermostat have been devised. Such thermostats cause the burner to operate more frequently, but at shorter intervals, so that the heating system, instead of being alternately warmed to a high level and then permitted to cool completely or nearly so, is kept at a more nearly uniform temperature. Such thermostats are of several distinct types, but the details of their design and operation are beyond the scope of this circular. The operating differential of such thermostats, is, instead of approximately 2°, only a fraction of a degree.

DUAL CONTROL

In automatic oil-burner installations there are boiler controls in addition to the room thermostat. The boiler controls are termed hydrostats or aqua-stats, if it is a hot-water system, pressure-stats or vapor-stats if it is a steam system (including vapor-vacuum and low-pressure steam plants), and furnace-stats or furnace switches for warm-air heating systems. This boiler control is operated dually with the room thermostat, and controls conditions at the heater while the thermostat controls temperatures in the room. The hydrostat keeps the temperature of the water in the boiler below a set upper limit, and the pressure-stat keeps the steam pressure within certain limits, regardless of the temperature conditions in the room. These boiler controls make for safety by limiting the boiler pressures and temperatures regardless of the call of the room thermostat for heat.

A duplex switch may be used on a steam boiler to stop the burner in case of abnormally low water level (loss of water) as well as to control the steam pressure. A furnace switch may be used to start and stop a circulating fan in addition to its principal function of governing the furnace temperature. Another control is designed to vary the temperature of the heating medium in accordance with the outside temperature. For example, on extremely cold days the maximum water temperature in a hot-water heating system might be permitted to reach 180° F., which is normally considered the maximum for open-type water systems, whereas on milder days the maximum water temperature permitted might be only 130°. This type of control provides additional comfort over that afforded by the ordinary limiting device. Another type of control will prevent the boiler (either hot-water or steam) from becoming abnormally cold during periods when the room thermostat is not calling for heat, and cause quicker response when the room thermostat calls for heat and starts the burner. In the case of a steam boiler, for example, the low-limit control will prevent the boiler-water temperature from dropping below a predetermined point, say 160°, even though the thermostat does not call for heat, and thus the time required for the burner to raise the steam pressure will not be as great as if the water in the boiler had cooled to approximately room temperature.

EMERGENCY OR SAFETY CONTROLS

In addition to regulating heat, it is essential that precaution be taken to cut off the burner if ignition fails to take place. In a few burner types, a drip bucket or sump is provided to catch the unburned fuel which flows to it when ignition fails. This device trips when a certain quantity has been delivered to it, and either cuts off the oil supply or breaks the power circuit, in either case rendering the burner inoperative as to flow of oil and generation of heat. The machine must then be reset by hand before operation can be resumed.

Another emergency control, designed on the assumption that so long as the pilot light burns the charge will be ignited, has a thermostatic member exposed to the heat of the pilot light which breaks the power circuit when the pilot light is extinguished.

When the general design of the burner is such as to make the catching of unburned oil and its subsequent delivery to a sump or drip bucket impracticable, the "stack control" is utilized. A thermostatic member is placed in the stack, and if it does not become heated after a predetermined period—indicating that the burner has failed to function—it breaks the power circuit and stops the motor and supply of oil. Controls using the same general principle are sometimes placed so as to receive energy directly from the combustion chamber.

Emergency controls called into action by low water in the boiler are also applied in some installations. Such devices as alarm bells are sometimes employed in conjunction with emergency controls. The low-water control is required by some communities, and its use is recommended.

STORING OIL AT THE HOME

In contemplating the installation of an oil burner, provision for storing fuel should be considered. For coal, the average home owner generally provides storage capacity for all the coal to be used during the heating season. With oil, this is not usually done. Storage tanks for domestic oil burners are offered in several sizes such as 270, 550, and 1,000 gallons. The 270-gallon size is used most commonly.

The former practice of oil companies of reducing the price of the oil when delivered in quantities of 1,000 or 2,000 gallons is no longer common, so now there is generally no fuel-price advantage from using the larger tank. As a matter of fact, it is now generally more expensive to use the larger storage tank because of its greater cost and because it usually must be buried out of doors in order to comply with fire regulations. Also with some types of burners, it is necessary to employ a separate transfer pump to lift the oil from the large buried tank and deliver it to the burner. The larger tank does have some advantage, however, where delivery of oil is not always easily obtained, as when roads become impassable, and the more frequent refilling required by a small tank may be annoying.

To some extent, the size of tank is dictated by the seasonal fuel consumption. One-fifth of all the oil used during the season may be required in one severely cold month. Thus an installation that uses 2,000 gallons in a season may require approximately 400 gallons during January, and a 270-gallon tank may require fuel deliveries every second week. If fuel consumption were 4,000 gallons per season, deliveries to a 270-gallon tank doubtless would be required once a week during part of the season and a 1,000-gallon tank—or at least two 270-gallon tanks—might prove more satisfactory. Bearing in mind that the severest month calls for about one-fifth the total season's demand, and that each of the two next in severity may require only slightly less, an estimate can be made of the number of deliveries necessary during a very severe winter. Route service, by which the responsibility of keeping the consumers supplied with oil, is offered by some fuel companies. Under this scheme, the company checks the contents of all tanks periodically without call from the householder.

Tanks are regularly supplied with gages, some of which are accurate whereas others indicate only roughly the amount of oil present. But even the latter serve satisfactorily in showing the necessity for refilling. Tank wagons are equipped with meters for measuring the quantities delivered, with pumps for forcing the oil into the consumer's tank, and with sufficient length of hose for easy delivery of fuel to any fill pipe within reasonable distance from a driveway that may be traversed by the oil truck. Many localities have ordinances that require the oil meters to be checked frequently.

Storage tanks should be installed in conformity with the local ordinances regulating such matters. The Underwriters' Laboratories, Chicago, Ill., issues pamphlets of direction for this work.

ADJUSTMENT OF BURNERS

After a burner has been installed in a boiler, it must be properly adjusted for efficient service. The adjustment consists of regulating the quantities of oil and air admitted. The rate of oil consumption depends on the heating load; that is, on the size, arrangement, and construction of the house, the room temperature to be maintained, the out-door temperatures, the exposure to winds, etc. The adjustment of the air admission depends upon the quantity of fuel to be burned, for a definite quantity of fuel burned requires a definite quantity of air.

Soot and smoke generally result if insufficient air is supplied. It is not easy to supply precisely the amount of air theoretically needed for perfect combustion, and even if this were accomplished the intermingling of the oil and air probably would not be sufficiently complete to give perfect combustion, so an excess of air is necessary to ensure that each subdivided bit of oil is provided with the amount of air needed. In practice possibly 25 to 50 percent more air is supplied than is theoretically required. An excess of air is also advantageous with automatic operation when the burner is started and stopped frequently, because it lessens the smoky condition which sometimes occurs when the burner comes on.

In general it can be said that introduction to the furnace of more air than is necessary for combustion reduces flame temperature and results in otherwise useful heat being carried up the chimney. It is not easy, however for the layman to determine how much excess air is being supplied to his burner; this can only be determined by an apparatus known as a flue-gas analyzer.

Today a large percentage of oil-burner installations include a so-called automatic draft control of some description, which helps to maintain the adjustment of the burner. This generally consists of a swinging check damper which automatically opens or closes in order to hold a predetermined draft intensity at the furnace. The intensity of this draft generally can be altered by moving a balance weight. Because such a device almost always helps burner operation and is low in cost, it might well be part of every burner installation. A slightly different automatic draft control acts as an ordinary shut-off damper instead of as a check damper, with probably the same principal effect. Figure 13 shows an automatic draft controller of the check-damper type.

It is of interest to note the large quantities of air required to support combustion in house heating. The oil fuels now employed are very uniform in composition and contain roughly 84 percent carbon and 13 percent hydrogen, oxygen, nitrogen, and sulphur together composing the other 3 percent. One gallon of such oil will require about 2,000 cubic feet of air for combustion. Thus, if a burner is using 2 gallons of oil per hour the air required each hour will be approximately 4,000 cubic feet, which is the equivalent of the entire content of a cellar 20 feet square and 10 feet high. Generally no additional opening to the ordinary cellar is required, because leakage into it will provide all the air necessary, but it is important to bear in mind that when the burner is located in a small cellar that is unusually tight, additional openings into the cellar may be required.

The adjustment of the burner should take into account the temperature of the gases passing from the heater to the chimney. If the temperature of these gases is too high, too little of the heat of the fuel has been absorbed by the boiler and the over-all efficiency is therefore low. When there are both a great excess of air and very high stack temperatures, the resultant over-all efficiency becomes very low indeed. Stack temperatures may be classified as low when between 300° and 400° F., medium when between 400° and 550°, high when between 550° and 650°, and excessive when 700° or higher. Use of the better boilers and boiler-burner units should result in stack temperatures of approximately 400° or less. Such temperatures are measured by means of mercury thermometers of special design, which may safely be used in registering temperatures up to 1,000°. These measurements can usually be made by a well-equipped and experienced oil-burner agent.

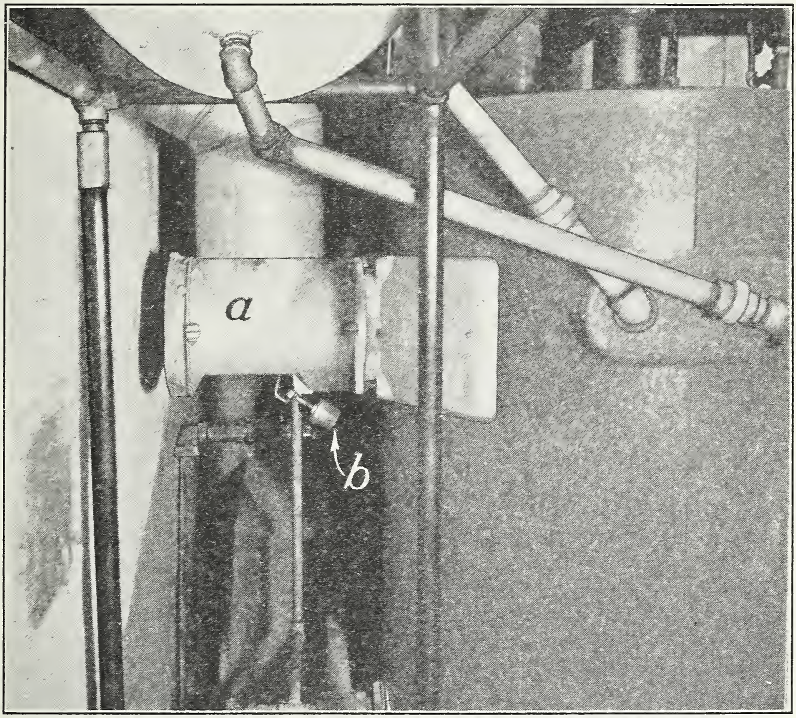

FIGURE 13.—Draft controller installed on boiler: *a*, Draft-controller casting; *b*, counter weight.

CARE OF BURNERS

A little care in following the printed directions of the manufacturers or distributors of the burner will be well repaid. Oil-burner men are subject to service calls for minor ailments that might easily be remedied by the owner. Many needless service calls are made because the owner failed to note that his fuel tank had become empty.

Instructions as to oiling and general care of the burner should be followed strictly. Different agents have different plans for the care of the burner. Some periodically overhaul and oil the moving parts at a nominal price, and thus each heating season is begun with a plant in good condition.

It is well for the home owner to refrain from attempting to adjust the rates at which oil and air are admitted to the burner. Admission of the proper proportions of air and fuel is generally provided by the installation man, and it is more than likely that any changes made by an inexperienced person will result in less favorable conditions.

SAFETY

Regardless of any advantages to be obtained from the installation of a safety device, no one would want to have a burner that he did not feel was reasonably safe. For the protection of purchasers and insurance companies the Underwriters' Laboratories [8] have investigated various burners submitted for their approval, and listed those which meet certain minimum requirements of safety. The underwriters do not test burners for efficiency. From their viewpoint the questions to be settled are: Will this burner set fire to the building in which it is installed, or is there a possibility of its causing an explosion, or being instrumental in injuring the person giving it the ordinary amount of attention required?

In general, the listing of any oil-burning equipment by Underwriters' Laboratories means that the equipment has been examined and tested, and found to comply with the minimum requirements in effect for its class, and that the manufacturer has agreed to maintain those minimum requirements and to identify the listed products with the marking agreed upon. Particular attention should be paid to the exact form of marking used to designate the listed device as stated on each card and in the regularly published list under the heading of "Marking". The listing of oil burners as standard does not mean that the products listed are necessarily equivalent in quality or merit. Any question with regard to the effect of the installation of an oil burner on insurance rates should be taken up with the company insuring the property or with local authorities having jurisdiction.

The underwriters' designation on a burner is a good guarantee of the safety of the device from the standpoint of a fire hazard. There are undoubtedly some burners which have not been submitted to the Underwriters' Laboratories for test which present just as little fire risk as those that have been tested and listed. It is highly desirable in contemplating the installation of an oil burner to familiarize one's self with the recommendations of those laboratories. Literature has been prepared and is available to the public.

In addition to the safety of the burner itself there are to be considered the matters of placing tanks, installation of piping, the burner proper, and in some cases the electric wiring. In handling all of the items the installer should follow the National Board of Fire Underwriters' rules and the local or national electric codes.

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[8] The Underwriters' Laboratories, Chicago, Ill., maintained by the National Board of Fire Underwriters

Investigations made by the Department of Agriculture have disclosed the fact that a great number of oil-burner fires can be traced to faulty installation and adjustment rather than inherent weakness in the burner.

COMPARISON OF HEATING WITH COAL AND WITH OIL

In comparing the cost of heating with oil and with coal, all factors must be considered. There is greater opportunity for poor firing with coal than with oil, because the personal element enters to a much greater degree with the coal fire. It is safe to say that only a small percentage of householders operate coal-heating plants to best advantage, principally because of poor room-temperature control. With the coal fire there is overheating during the milder periods of the heating season, especially when no automatic room-temperature control is used. Temperature regulation is frequently achieved by opening windows and doors, rather than by control of the fire. These things greatly lower the seasonal plant efficiency.

The average temperature maintained inside the house affects fuel consumption to a much greater degree than is generally understood. In Washington, D. C., for example, nearly one-fifth more fuel is required to heat a house to 75° F. than to 70°. About 7 percent more fuel is needed to heat to 72° than is required to heat to 70°. It is not recommended that abnormally low temperatures be carried for saving fuel, but it is well to realize that overheating a house only a few degrees can cause a large increase in fuel consumption as well as produce an uncomfortable and possibly unhealthful condition.

Where coal is burned, some auxiliary heating devices such as portable oil, gas, or electric heaters may be put into service in the mild early and late heating periods. The cost of operating these should be included in the cost of heating with coal, when making comparison with oil heating.

With an oil burner properly installed and regulated, the personal element is largely removed. An oil burner may be operated earlier in the fall and later in the spring than a coal heater because of the ease of starting, and because presumably a minimum of care is required afterwards. The room temperature, with a good automatic oil-burning installation, is maintained practically constant at any ordinarily desired temperature, which is not commonly the case with the coal burner.

It should be borne in mind that the usual oil-burning installation is merely a change over from coal burning to oil without any radical change in the boiler. There are many types of boilers in use, and some are far more suitable for oil burning than others. A definite comparison between the costs of heating with oil and with coal for any particular case would require consideration of the type and size of boiler, the care given the operation of the coal-burning plant, and the prices for the different kinds of fuel, even with a burner selected as suitable for the boiler used.

The Department of Agriculture found, in studies of the comparative consumptions of coal and of oil in small round boilers such as would be found in an average dwelling house, that 1 short ton of coal hand-fired may be the equivalent of from 150 to 200 gallons of oil fuel. (Stoker-fired or other special coal-burning furnaces are commonly more efficient than coal-burning heaters.) This large range in equivalents is due to a great variation in the efficiencies of different boilers, and to a great difference in the control of temperature. The higher figures apply where the boiler is not well suited for oil burning, and the lower figures where conditions for burning oil are very favorable or where the coal-burning boiler is replaced by a special oil-burning type.

By estimating the oil-coal equivalent and applying local fuel prices, an approximation of the relative costs of fuel may be computed for any particular case. Interest and depreciation on the burner-installation cost must be included in the cost of heating with oil, and for a small installation this charge may equal a considerable portion of the fuel cost. The cost of auxiliary power—electricity, gas, or both—may be $1 or more per month; the amount varies greatly with burner types and with utility prices. After the free-service period, which generally lasts 1 year, service charges must be reckoned with unless service is included in the price of the oil. With good burners, properly installed, service charges should be small.

Against the greater cost of heating with oil, may be set the cost of employing an attendant for the plant, often required for a coal furnace, but unnecessary when oil is used. It is claimed also that with a properly adjusted oil burner the cost of cleaning and redecorating the home is greatly lessened.

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